Acidification and Eutrophication under Cost-optimal Baseline and Various Ambition Scenarios

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Scenarios (as of 16 Feb 2011)

Year: **2020**, all based on PRIMES model

Reference: **Cost-optimal Baseline** (COB)

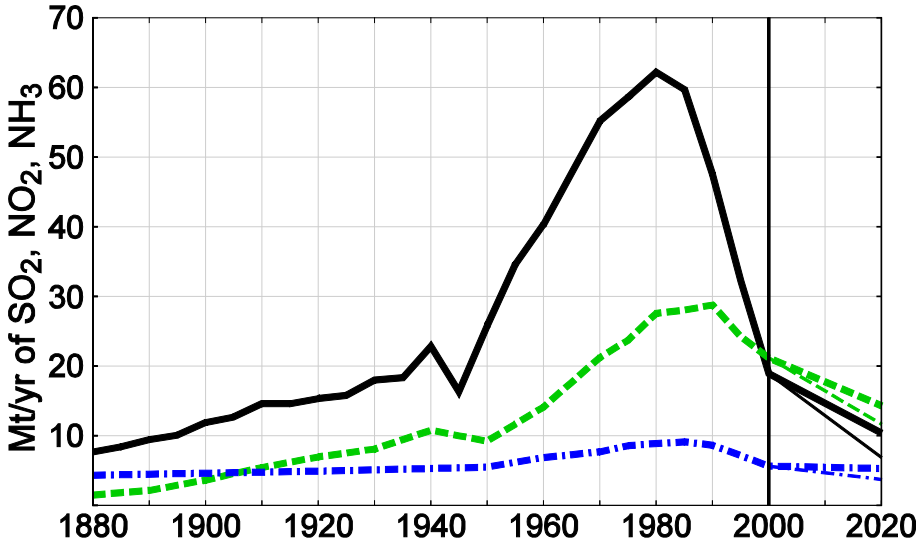
5 ambition levels:

Table 5.1: Summary of gap closure percentages for the impact indicators

Scen	Health-PM	Acidification	Eutrophication	Ozone
HIGH	75%	75%	75%	75%
High*	75%	75%	75%	50%
Mid	50%	50%	60%	40%
Low*	25%	25%	50%	25%
LOW	25%	25%	25%	25%

+ Maximum Feasible Reductions (MFR)

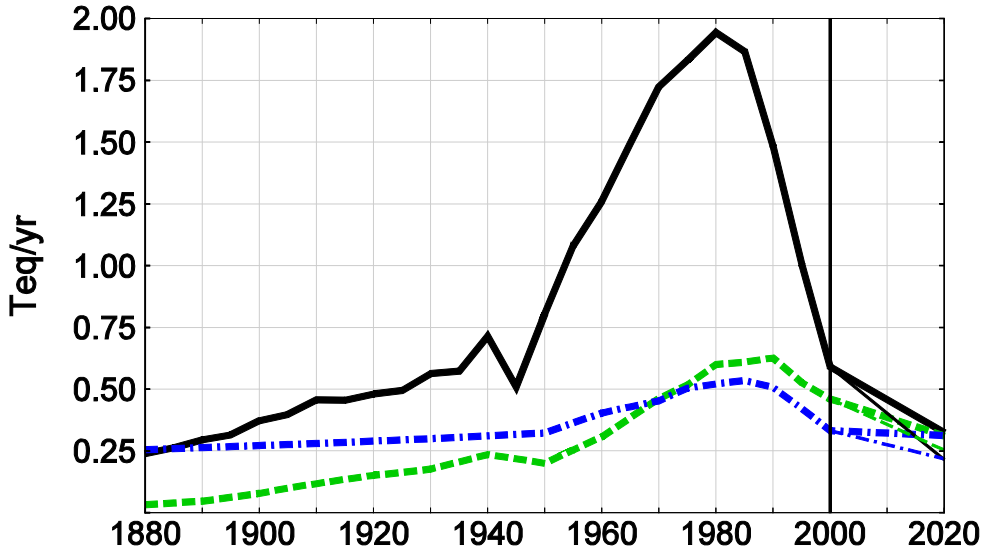
European's temporal emissions



Mt or Tg SO_2
Mt or Tg NO_2
Mt or Tg NH_3

(Tera = 10^{12})

… but ecosystems don't see tons …



Teq S
Teq N
Teq N

➔ **NH_3 more prominent!**

Emissions in 2020

Scen	SO2	NO2	NH3	S	NOx-N	NHy-N
2020	|---	kt/yr	----|	|---	Geq/yr	---|
COB	10405	14313	5304	**325**	**311**	**312**
LOW	9998	13715	4749	**312**	**298**	**279**
Low*	10085	13666	4356	**315**	**297**	**256**
MID	9137	13156	4256	**286**	**286**	**250**
High*	7583	12700	4029	**237**	**276**	**237**
HIGH	7813	12041	4159	**244**	**262**	**245**
MFR	6930	11662	3708	**217**	**254**	**218**

➔ In 2020 all 3 pollutants emitted in about equal amounts (in eq !!)
➔ Twice as much total N as S enters ecosystems

Better historical emissions:

➔ Lamarque J-F et al. (2010) Historical (1850-2000) gridded anthropogenic and biomass burning emissions of reactive gases and aerosols: methodology and application. *Atmospheric Chemistry and Physics* 10: 7017-7039

➔ Smith SJ, Van Aardenne J, Klimont Z, Andres RJ, Volke A, Delgado Arias S (2011) Anthropogenic sulfur dioxide emissions: 1850-2005. *Atmospheric Chemistry and Physics* 11: 1101-1116

Areas exceeded (& AAE) of Acidity Critical Loads

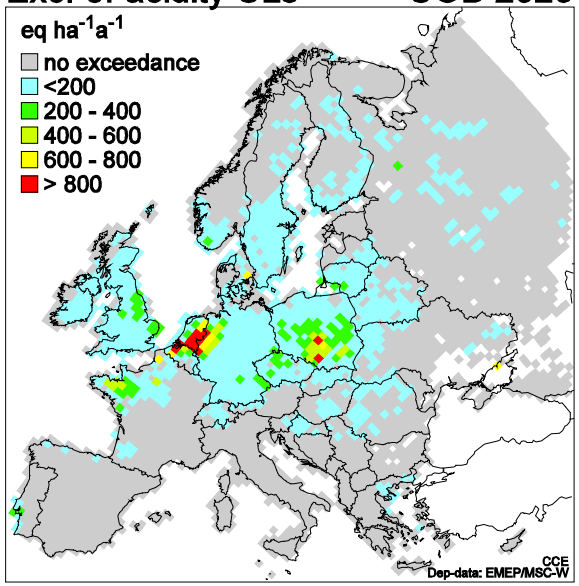
Scen	Europe		EU27	
	Area %	AAE eq/ha	Area %	AAE eq/ha
COB	3.53	9.949	5.96	19.397
LOW	2.98	7.465	5.09	14.652
[Low*	2.80	6.617	4.78	12.935]
MID	2.38	5.203	4.06	10.248
[High*	1.80	3.795	3.20	7.692]
HIGH	1.92	3.972	3.39	8.055
MFR	1.42	2.833	2.60	5.763

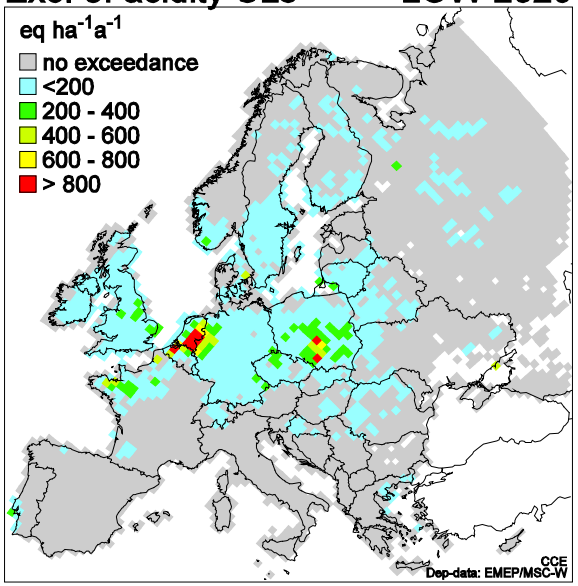
Acidity:

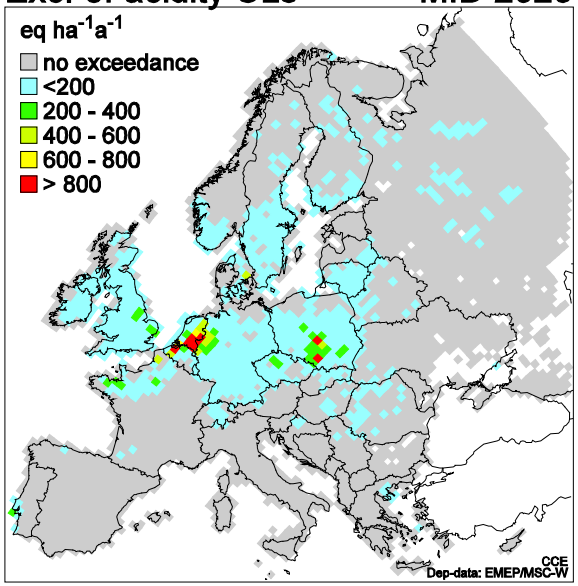
1 Amb-level up ≈ 0.5% ecosystem area more protected

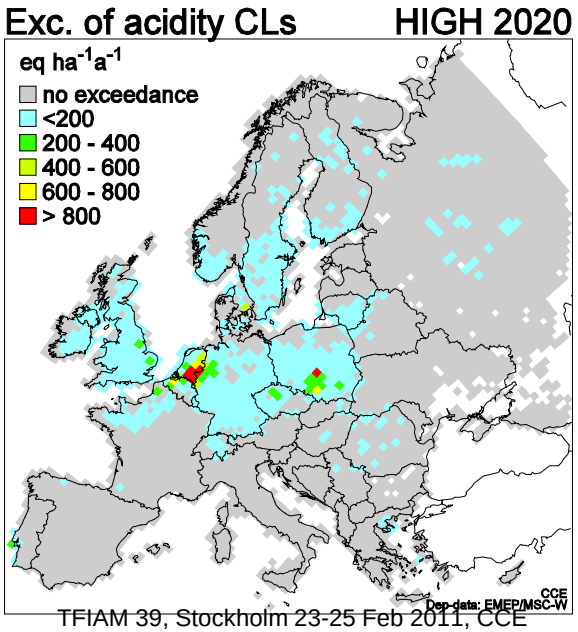
≈ 20,000 km^2 of ecosystems

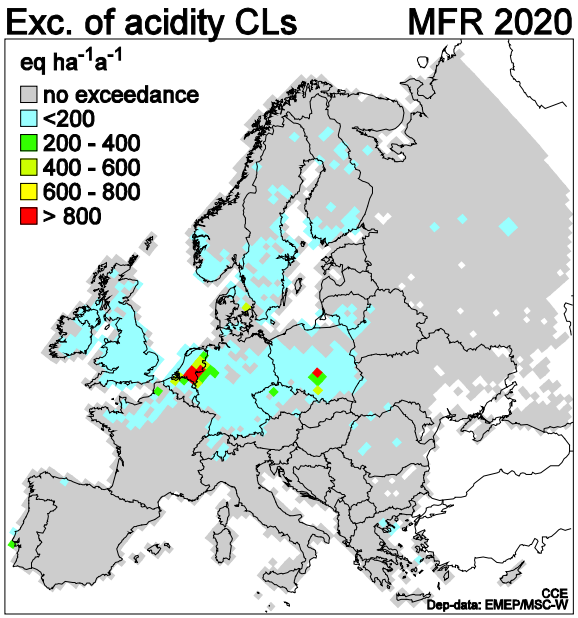
Exceedances (AAE) of Acidity Critical Loads (2)











Dynamic Modelling -- Target Loads* (TLs) for 2050

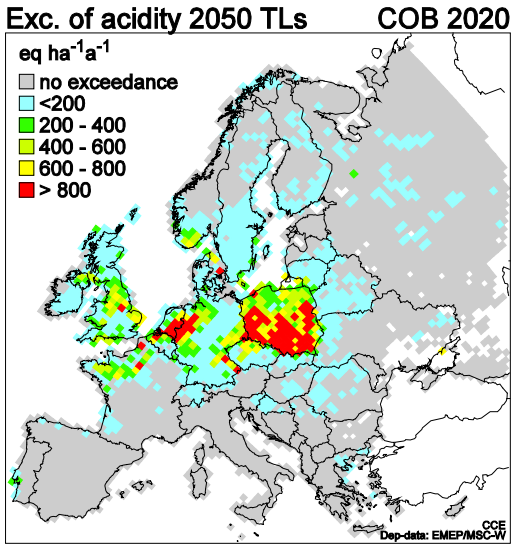
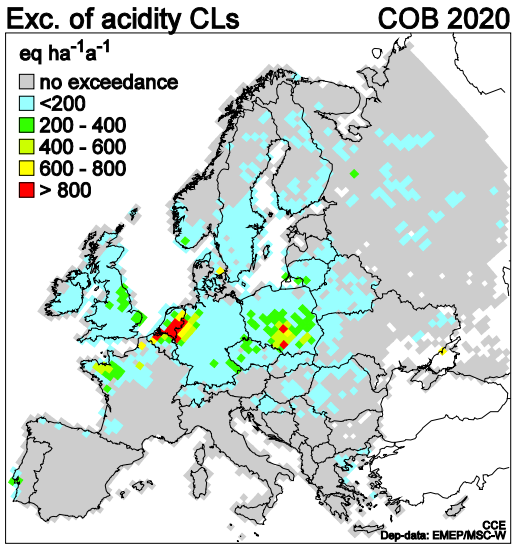
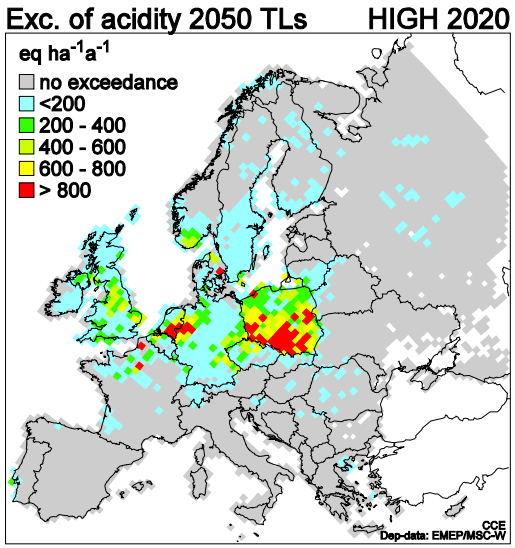
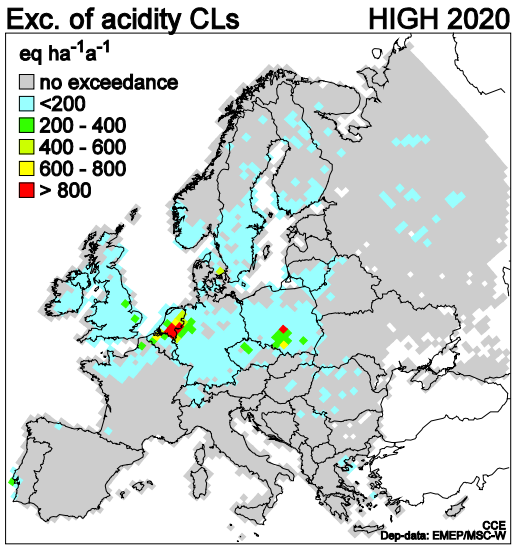
Acidification:

	TL2050		CL	
Europe:				
	%	eq/ha	%	eq/ha
COB	**5.16**	**32.4**	3.53	9.9
HIGH	**3.80**	**22.9**	1.92	4.0
EU27:				
COB	**9.04**	**65.5**	5.96	19.4
HIGH	**6.97**	**46.8**	3.39	8.1

… especially exceedances (much) higher!

*Def: If Dep ≤ TL (in 2020), chemical criterion met in target year (2050)

Acidity 2050 Target Loads (compared with CLs)

	Target Loads	CLs
COB (CLe)		
HIGH		

Area exceeded (& AAE) of Nutrient N Critical Loads

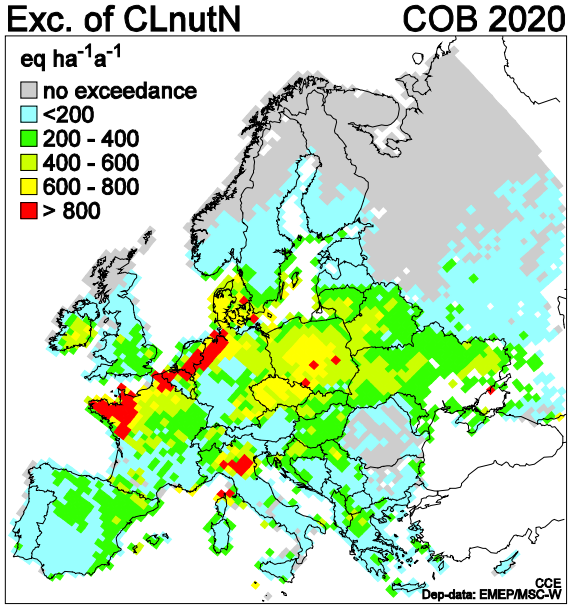
Scen	Europe		EU27	
	Area	AAE	Area	AAE
	%	eq/ha	%	eq/ha
COB	36.61	93.702	57.96	163.989
LOW	32.11	71.755	52.12	126.117
[Low*	29.80	59.959	48.49	105.134]
MID	27.67	53.588	45.98	95.309
[High*	25.16	45.424	42.22	82.435]
HIGH	24.87	45.218	42.10	82.328
MFR	21.29	33.880	36.16	62.829

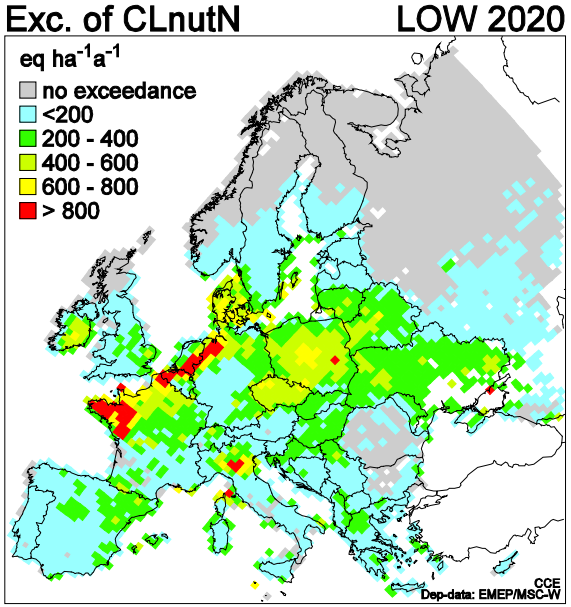
Eutrophication:

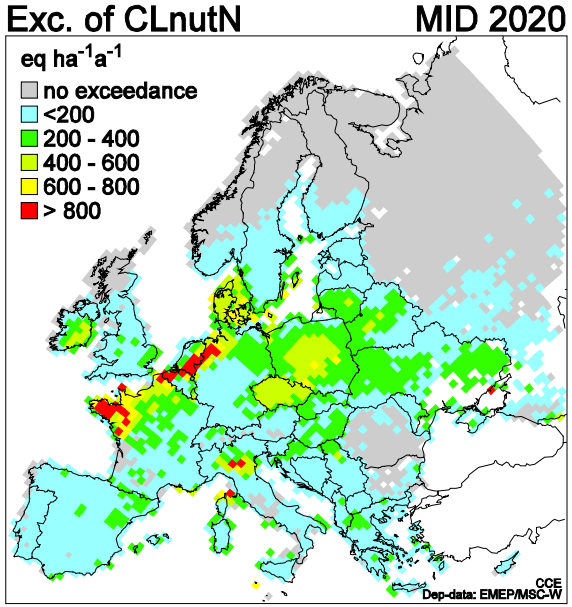
1 Amb-level up ≈ 3% ecosystem area more protected

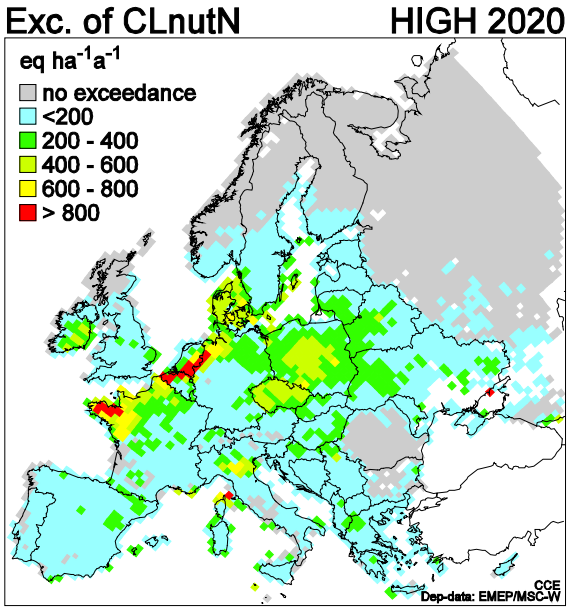
≈ 120,000 km² of ecosystems

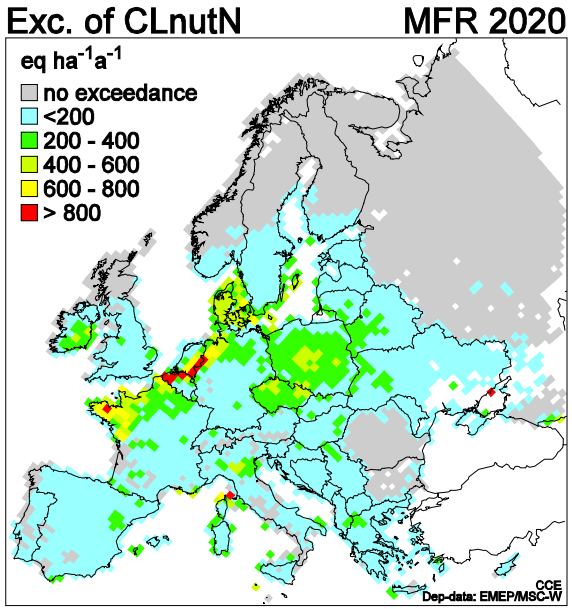
Exceedances (AAE) of Nutrient N Critical Loads











Dynamic Modelling -- Target Loads* (TLs) for 2050

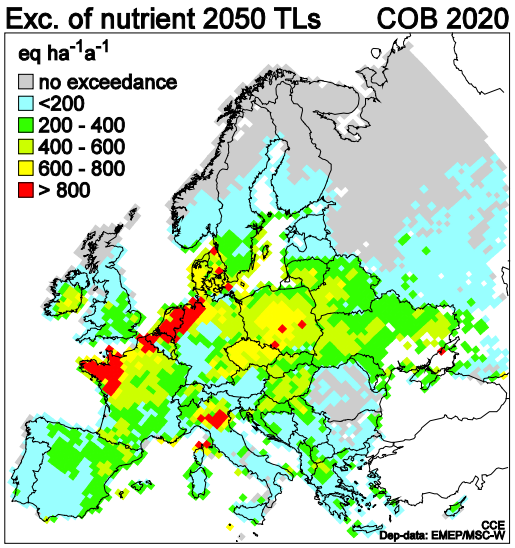
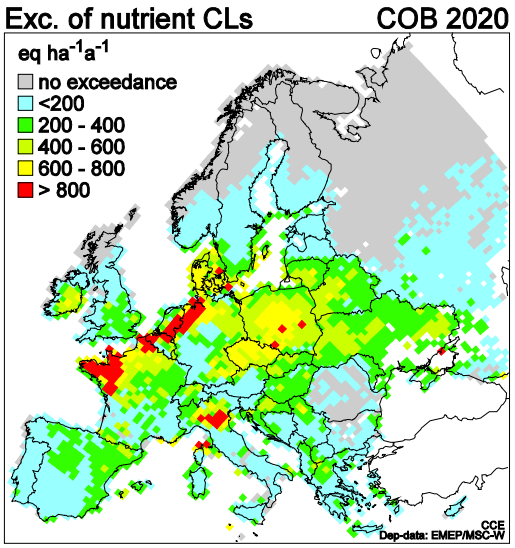
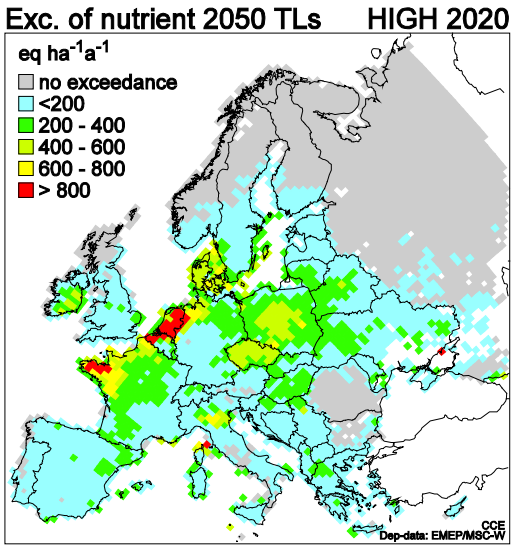
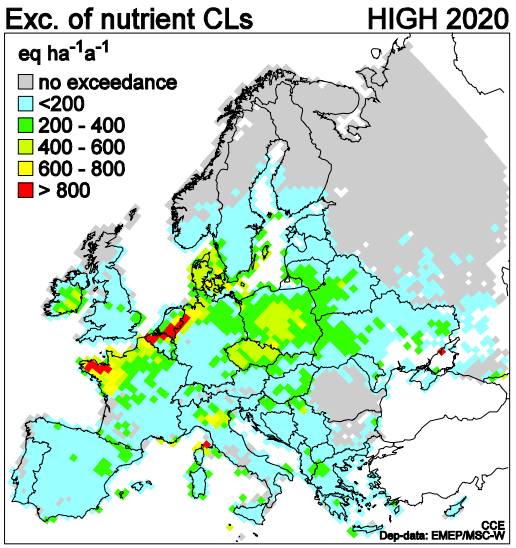
Eutrophication:

	TL2050		CL	
Europe:				
	%	eq/ha	%	eq/ha
COB	**37.51**	**99.5**	36.61	93.7
HIGH	**26.12**	**50.0**	24.87	45.2
EU27:				
COB	**60.06**	**177.3**	57.96	164.0
HIGH	**44.96**	**93.3**	42.10	82.3

… obviously higher but not so much!

*Def: If Dep ≤ TL (in 2020), chemical criterion met in target year (2050)

Nutrient N 2050 Target Loads (compared with CLs)

	Target Loads	CLs
COB (CLe)		
HIGH		

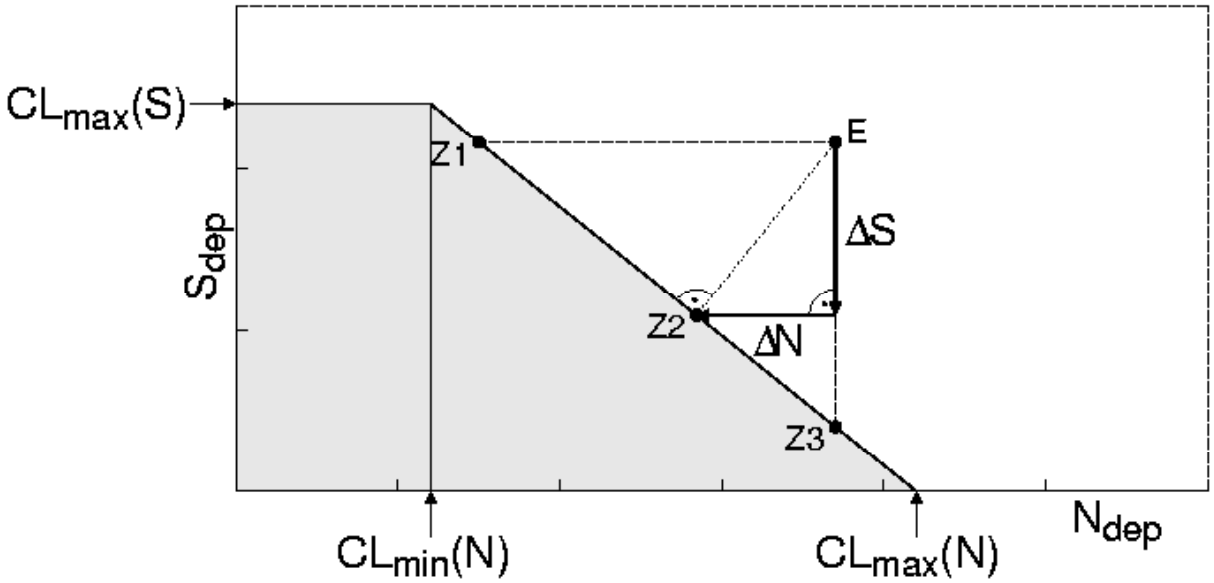
Thank you! …….. Any Answers?

Exceedances

One ecosystem:

Nutrient N: $Ex_{nut} = N_{dep} - CL_{nut}(N)$

Acidity CL function: $Ex_{aci} = \Delta S + \Delta N$



Many ecosystems: $$AAE(N_{dep}, S_{dep}) = \sum_{i=1}^{n} A_i \cdot Ex_i(N_{dep}, S_{dep}) / \sum_{i=1}^{n} A_i$$